

A STUDY OF DERMAL AND INHALATION EXPOSURE OF
MIXER-LOADERS TO PESTICIDES WHILE
USING A CLOSED MIXING AND LOADING SYSTEM

By

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SUMMARY

Concerns about the effectiveness of closed systems prompted the exposure monitoring of mixer/loaders who use Toxicity Category I liquid pesticides. During the summer of 1986, in Santa Barbara County, a study was conducted to monitor mixers and loaders for aerial applications using a closed system equipped with a retractable probe. Personal air samples, dermal gauze pads and handwashes were used to estimate worker exposure. Estimated exposures ranged from 2.1 to 20.7 micrograms per pound of active ingredient used during the monitored exposure periods of two individuals.

INTRODUCTION

Ten years ago the use of closed systems was implemented in order to reduce the potential hazards in human exposure to highly toxic pesticides. Hand pouring is the most hazardous activity involved in handling Toxicity Category I liquid pesticides and can result in the most serious human illnesses. For this reason, California pesticide worker safety regulations (Article 2, Section 6746 of the California Administrative Code) require that employees who mix or load liquid Category I pesticides must do so through a closed system.

Closed mixing systems consist of various mechanical devices that transfer metered amounts of pesticide concentrates directly from its original container to mixing or application tanks. This eliminates human exposure when measuring out a pesticide by hand pouring.

The most commonly used closed systems consist of probes, vacuum or gravity transfer and a metering apparatus. Some units are self-rinsing (transfer rinsing water to the tank) or incorporate can crushing components.

This study was designed to monitor the exposure of persons mixing and loading liquid Category I concentrate pesticides while using a closed system equipped with a retractable probe.

MATERIALS AND METHODS

Inhalation and dermal exposure were measured during mixing and loading operations for several aerial applications. Two individuals were monitored during a total of four exposure periods. The pesticides used include azinphos-methyl (Guthion^R 2S, EPA 3125-123-ZC), dimethoate (Dimethoate 267, EPA 279-2821-AA), and mevinphos (Phosdrin^R 4EC, EPA 201-289-AA). Dimethoate is not a Category I material but the exposure period was monitored because it was handled through a closed system. Application information is in Appendix 1. The closed system used was built by the applicator and met the requirements of the closed system criteria.

The aerial applicator used a multiple-use nurse truck to transport water and other materials to the job site. The calibrated (marked) retractable probe was mounted on this unit to produce a closed system operation. The hand-held probe was inserted into the original containers via connecting suction hoses that extract the material. A operating pump used to mix the material provided the vacuum necessary to empty the containers and transfer it to the vehicle tank. The vehicle tank was equipped with a calibrated sight gage to indicate specific quantities released into the tank and with shut-off valves in case of breakage or leakage. Once emptied, the containers were flushed with fresh water through the outside tube of the probe to rinse the containers and the rinse solution went into the pesticide mix tank via the closed system. A dry-coupler was installed at the hose disconnect-point to minimize pesticide drippage. The system also provided a powder box for introducing powders directly into the mix tank, the contents were diluted with appropriate water and pumped into the aircraft.

In all of the exposure situations, workers wore standard Tyvek^R coveralls, waterproof gloves, rubber boots, respirators, hats and face shields.

Inhalation exposure was measured by using personal air pumps (MSA Model G). The sample media consisted of glass fiber filters (0.3 um pore size, 37 mm in diameter) mounted in cassettes followed by two-stage 40/80 mg XAD-4 resin sorbent tubes located in the worker's breathing zone. Sampling rate was one liter per minute.

Dermal exposure was measured by two methods, handwashes and non-sterile surgical gauze pads. This pad method is similar to that of Durham and Wolfe (1962). The amount of material found on each pad is divided by the surface area of the sampling pad(s) (23.75 cm²/pad). This value is multiplied by the surface area of the body part which each pad represents. The amounts per body part are added together to achieve total body exposure. Body surface areas for estimated dermal exposure are taken from Popendorf and Leffingwell (1982).

The handwash samples were taken by washing the worker's hands with 250 ml of distilled water in one-gallon Ziploc^R bags. The handwash water was transferred to glass jars, covered with aluminum foil, sealed with screw caps and refrigerated with wet ice. Gauze pads consisted of 12 layers of non-sterile surgical cotton gauze inside foil backed paper envelopes. Pads were mounted with safety pins on the inside and outside of the worker's protective Tyvek^R coveralls at predetermined sites: thighs, lower legs (below the knee), chest, back, upper arms and forearms. At the end of the exposure period, the pads were removed and transferred to glass jars and stored in the same fashion as the handwash samples. All samples were transported in iced containers to Sacramento for analysis by the Chemistry Laboratory Services. Information on analytical methods for each sample type and compound used can be obtained upon request. Minimum detectable level of pesticides used in this study are listed in Appendix II.

RESULTS AND DISCUSSION

The following table gives the estimated dermal exposure for the four periods monitored in micrograms.

Hours Per Exposure Period	Pesticide	Pounds Used	Hand Exposure	Exposure Level Under Coveralls	Exposure Per Pound Used*	Exposure Level Outside Coveralls
2	Azinphosmethyl	17.25	8	188.61	11.4	2654.46
	Mevinphos	10	145	<MDL	14.5	1226.15
2	Mevinphos	52.5	111	<MDL	2.11	684.95
3	Dimethoate	68	1308.7**	99.64	20.7	2624.25
2	Mevinphos	20	<MDL	783.90	39.2	791.74

MDL = minimum detectable level.

* Includes exposure under coveralls and handwashes.

** This includes a combination of four separate handwashes.

Exposure period three had the only positive air sample of 0.014 mg/m³ or approximately 63 ug exposure for the time monitored at a 25 liter per minute breathing rate.

In studies conducted by Peoples et al. 1981, mixer/loaders working with DEF^R and Folex^R had calculated exposure levels ranging from 4.8 to 38.3 micrograms per pound used. Workers mixing/loading nitrofen were exposed to 11.9, 13.8 and 19.7 micrograms per pound used (Maddy et al. 1980).

Data was unavailable for workers mixing and loading without a closed system using similar materials.

Knaak et al. 1980, measured the cholinesterase inhibition and conducted air monitoring of workers mixing and loading mevinphos but no direct dermal exposure monitoring was done. During exposure period three there was one positive air result at 14 ug/m³ while Knaak et al. 1980, found levels averaging 9.27 ug/m³ over five monitoring periods. Knaak et al., 1980, also found red cell cholinesterase inhibition in the workers and noted instances of small spills on the workers clothing during loading. In our study, no spills were noted and the workers were well trained in the use of the closed system.

Closed systems can be an effective means of preventing exposure if the workers are properly trained in the systems use and the system is maintained. Based upon pesticide illness reports (Worker Health and Safety Branch, California Department of Food and Agriculture 1975-1985) the use of closed systems have reduced the number and severity of illnesses of mixers and loaders.

APPENDIX 1

Pesticide Used During the Four Exposure Periods

<u>Exposure Period</u>	<u>Chemical</u>	<u>Formulation Type</u>	<u>Pounds of Active Ingredient Per Gallon</u>	<u>Amount/Acre Formulated Product</u>	<u>Acres Treated</u>
1	Guthion 2S Phosdrin 4EC	Emulsifiable Liquid Emulsifiable Concentrate	2 4	3 Pints 1 Quart	23 Potato 10 Cauliflower
2	Phosdrin 4EC Phosdrin 4EC Phosdrin 4EC Phosdrin 4EC	Emulsifiable Concentrate Emulsifiable Concentrate Emulsifiable Concentrate Emulsifiable Concentrate	4 4 4 4	1 Quart 1 Quart 1 Pint 1 Quart	9.5 Broccoli 23 Broccoli 9 Celery 11 Broccoli
3	Dimethoate 267	Emulsifiable Concentrate	2.67	1.5 Pint	43.5 Bean 45 Bean 47.5 Bean
4	Phosdrin 4EC	Emulsifiable Concentrate	4	1 Quart	20 Lettuce

All applications were delivered by helicopter.

APPENDIX II

Minimum Detectable Levels According to Sampling Media

<u>Pesticide</u>	<u>Handwash</u> <u>(ug Per Sample)</u>	<u>Gauze Pads</u> <u>(ug Per Sample)</u>	<u>Glass</u> <u>Fiber Filters</u> <u>(mg/m³)</u>	<u>Sorbent Tubes</u> <u>(mg/m³)</u>
Azinphosmethyl	5.0	0.5	.002	.002
Mevinphos	5.0	1.0	.003	.003
Dimethoate	5.0	2.0	.004	.004

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